Constructed wetland implemented in a tourism unit for wastewater treatment

the international water association

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INTRODUCTION

Sustainable water management implies the use of water in the most efficient way and the promotion, with the least impact to the environment, of the wastewater treatment (1). To establish effective wastewater treatment when a sewerage network is absent in mountain and rural areas, where the implementation of conventional systems may be impossible due to the technological complexity and associated costs of operation and maintenance, is a great challenge. Tourism units that face these scenarios also encounter a great variation in the quantity and quality of the produced wastewater over the year. The use of ecotechnologies, namely constructed wetlands, with the latter purpose arise as a promising solution, requiring understanding of the structures and processes of ecosystems and societies. Constructed wetlands (CW) are man-made systems that intend to mimic the biogeochemical processes that occur in natural wetlands in order to boost wastewater depuration. They have been considered for application to a range of different types of wastewater and in several locations worldwide (2,3). Due to the specificity of the wastewater produced in tourism units and the fact, that they are often located in mountain and rural areas where sewerage system is absent, CW may be a feasible option to cope with such conditions in an efficient and sustainable way.
The present research analyses the functioning of an established CW in a tourism unit, where a polyculture of ornamental plants and selected substrate are in use. The outcomes of the study will support good practices towards application of these systems.

METHODS

The CW is implemented in a tourism unit, Paço de Calheiros, located in a rural area in the North of Portugal. The CW (Figure 1) is vegetated by (a) *Zantedeschia aethiopica,* (b) *Canna indica,* (c) *Agapanthus africanus,* (d) *Canna flaccida* and (e) *Watsonia borbonica*, in an expanded clay substrate (Leca®M). Operates with a subsurface flow mode, occupying an area of 40.5 m^2.

Plants were visually inspected on a weekly basis and shoot density followed. Biodiversity inhabiting the system was monitored. Chemical analyses were based on Standard Methods: total suspended solids, chemical oxygen demand (COD), biochemical oxygen demand (BOD), pH and conductivity. The nutrient analysis, namely nitrogen and phosphorus, was attained using known colorimetric methods, employing sequential injection analysis (6).

Figure 1 – Constructed wetland vegetated with a polyculture of ornamental plants

RESULTS

After ten months of the CW operation, there was no significant difference between the height of each plant species at inlet and outlet zones. After one year of operation the CW was fully vegetated with no visually differences between compartments. *A. africanus* was the only plant that almost disappeared from the CW. According to the season the CW exhibits distinct tones due to the different time of flowering of each species.

Monitoring campaigns (Figure 2) were carried out and the horizontal subsurface flow CW has shown to be effective in removing organic matter, up to 99% concerning BOD_5 (inlet 185±122 mg L^{-1}) and COD (inlet 371±304 mg L^{-1}). Inlet and outlet values for other parameters were, respectively: PO_4^{3-}: 11 (±8) mg L^{-1} and 3 (±2) mg L^{-1}, NH_4^+: 18 (±13) mg L^{-1} and 15 (±11) mg L^{-1}, NO_3^-: 11 (±9) mg L^{-1} and 2 (±2) mg L^{-1}, pH: 6.95 (±0.43) and 7.41 (±0.27), Cond.: 0.45 (±0.29) dS cm^{-1} and 0.38 (±0.18) dS cm^{-1}.

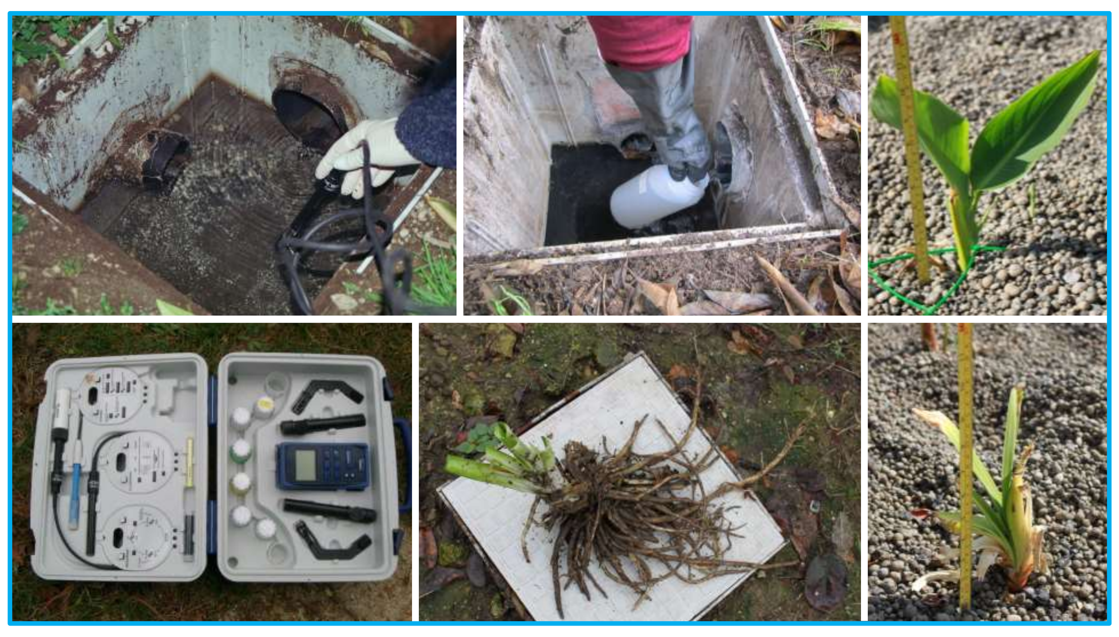

Figure 2 – Constructed wetland monitoring

DISCUSSION

The CW established complies with situations often found in the tourism sector displaying resilience and robustness, in terms of performance and plant survival.

There are evidences that polyculture systems have an impact on the root biomass and microbial populations of the CW, supporting improvements in wastewater quality (4). It has been suggested that it is possible to use ornamental plants in CWs without jeopardizing the treatment efficiency (5). However, little information is available on the use of ornamental plants with mix cultures in CWs facing oscillations in the feed.

One of the goals of using an ornamental polyculture was to promote ecosystem services encountering the principles of biomimetics, providing at the same time landscaping integration and respecting tourism and rural dynamics (Figure 3 and 4).

Figure 3 – Biodiversity monitoring

Figure 4 – Constructed wetland integrated in the rural scenario

CONCLUSIONS

Considering the fundamental purpose of public health and environmental protection, CWs are an interesting and economically feasible option for use as an integrated wastewater management system for remote tourism units. Main findings:

- Ornamental polyculture systems are effective for wastewater treatment in CW.
- High removal efficiencies were achieved concerning organic loads and the system proved to be robust, tolerating fluctuations in the feed.
- The flowers produced can be used for decorative purposes.
- Local biodiversity enhancement was registered, and CW was recognized as a landscape requalification system and a platform for pedagogic assays.

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Acknowledgement: C.S.C. Calheiros and R.B.R. Mesquita thank to Fundação para a Ciência e a Tecnologia (FCT) and Fundo Social Europeu through the program POPH – QREN the grants SFRH/BPD/63204/2009 and SFRH/BPD/41859/2007, respectively. This work was supported by National Funds from FCT through project PEst-OE/EQB/LA0016/2013. The authors are thankful for the collaboration of Paço de Calheiros and Saint-Gobain Weber Portugal, S.A.